

LONDON- WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 5 | Technical Appendices

CFA17 | Offchurch and Cubbington

Water resources assessment (WR-002-017)

Water resources

November 2013

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Department
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Appendix WR-002-017

Environmental topic:	Water resources and flood risk assessment	WR
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1 Introduction

1.1 Structure of the water resources and flood risk assessment appendices

- 1.1.1 The water resources and flood risk assessment appendices comprise three parts. The first of these is a route-wide appendix (Appendix WR-001-000).
- 1.1.2 Two specific appendices for each community forum area (CFA) are also provided. For the Offchurch and Cubbington area (CFA17), these are:
- a Water Resources Assessment (i.e. this appendix);
 - a Flood Risk Assessment (Appendix WR-003-017); and
 - a River Modelling Report (Appendix WR-004-010).
- 1.1.3 Maps referred to throughout the water resources and flood risk assessment appendices are contained in the Volume 5: Map Book – Water resources, Maps WR-01 to WR-03, WR-05 and WR-06 and the Volume 5: Map Book – Ecology, Maps EC-01 to EC-04.

1.2 Study area

- 1.2.1 The study area for Offchurch and Cubbington is located between Bascote and Cubbington and within the county of Warwickshire. The study area is predominantly rural and overlies superficial deposits and Mercia Mudstone Group Bedrock. Topography varies between 55m and 100m above ordnance datum (AOD).
- 1.2.2 The spatial scope of the assessment was based upon the identification of surface water and groundwater features within 1km of the centre line of the route, except where there is clearly no hydraulic connectivity. For surface water features in urban areas, the extent was reduced to 500m. Outside of these distances it is unlikely that direct impacts upon the water environment will be attributable to the Proposed Scheme. Where works extend more than 200m from the centre line, for example at stations and depots, professional judgement was used in selecting the appropriate limit to the extension in spatial scope required. For the purposes of this assessment this is defined as the study area.
- 1.2.3 Due to the number of ponds and other water features present within the study area, only those either within the land required for the construction or operation of the Proposed Scheme, or within the calculated zone of influence have been included in the assessment.

2 Stakeholder engagement

2.1.1 Discussions with the following stakeholders has been undertaken to inform the water resources assessment:

- the Environment Agency on 31 September 2012 to discuss multiple aspects of the Proposed Scheme;
- the Environment Agency on 21 December 2012; and
- the Environment Agency and Warwickshire County Council (WCoC) as Lead Local Flood Authority (LLFA) on 4 June 2013.

3 Baseline data

3.1 General

- 3.1.1 The following section provides a current description of water resources including surface water and groundwater.

3.2 Surface water features

- 3.2.1 All surface water features within 1km of the route are presented in Table 1.
- 3.2.2 The current surface water baseline is shown in the Volume 5: Maps WR-01-028 and WR-01-029. Where a water feature in Table 1 has been given a map reference it appears on one of these maps.

Appendix WR-002-017 | Baseline data

Table 1: Surface water features within 1km of the route in CFA17

Water feature ¹	Location description (map reference ²)	Watercourse classification ³	Water Framework Directive (WFD) Water Body and overall status	WFD status objective (by 2027 ⁴ as per River Basin Management Plan (RBMP ⁵), unless stated)	Receptor value ⁶	Q95 ⁷	Catchment	Size	Notes
Drain	At Burley Stud Farm 370m north-east of the route Map WR-01-028 (H5)	Ordinary watercourse	Grand Union Canal, Braunston to Leamington Spa (GB70910511) Good potential	Good potential	Moderate	-	-	-	Will not be crossed by the route.
Feeder stream to Grand Union Canal	At Welsh Road Bridge 300m north-east of the route. Extended culvert possible feeder stream to Grand Union Canal. Map WR-01-028 (H6)	Ordinary watercourse	Grand Union Canal, Braunston to Leamington Spa (GB70910511) Good potential	Good potential	Moderate	-	-	-	Will not be crossed by the route.

¹ Only ponds under the land take for the proposed scheme are listed in this table.

² Map references taken from Volume 5: Map Book – Water resources Maps WR-01-028 and WR-01-029.

³ Environment Agency water-feature classification: The Land Drainage Act 1991 defines an Ordinary watercourse as 'A watercourse that is not part of a main river, all rivers and streams, ditches, drains, cuts, culverts, dikes, sluices, sewers (other than public sewers) and passages through which water flows'. 'Main Rivers' are larger rivers and streams designated by DEFRA, main rivers are regulated by the Environment Agency.

⁴ Year may vary in different RBMPs.

⁵ The Environment Agency (2009), *River Basin Management Plan – Severn River Basin District* (p14).

⁶ For examples of receptor value see Table 43 in the SMR addendum Volume 5 Appendix CT-001-000/2.

⁷ Q95 flow values only provided for water features crossed by the route.

Water feature ¹	Location description (map reference ²)	Watercourse classification ³	Water Framework Directive (WFD) Water Body and overall status	WFD status objective (by 2027 ⁴ as per River Basin Management Plan (RBMP ⁵), unless stated)	Receptor value ⁶	Q95 ⁷	Catchment	Size	Notes
Drain	Lower Print Farm – north of Grand Union Canal located 370m north-east of the route Map WR-01-028 (H6)	Ordinary watercourse	Grand Union Canal, Braunston to Leamington Spa (GB70910511) Good potential	Good potential	Moderate	-	-	-	Will not be crossed by the route.
Tributary of River Leam	At Longhole Bridge Will be crossed by the route Map WR-01-028 (H6) (SWC-CFA17-001)	Ordinary watercourse	Grand Union Canal, Braunston to Leamington Spa (GB70910511) Good potential	Good potential	Moderate	-	Grand Union Canal	Not defined within low flows.	
Grand Union Canal	At Longhole Bridge Will be crossed by the route Map WR-01-028 (H6) (SWC-CFA17-002)	Artificial	Grand Union Canal, Braunston to Leamington Spa (GB70910511) Good potential	Good potential	High	-	Grand Union Canal	Not defined within low flows.	
Drain	At Longhole Bridge located 95m south-west of the route Map WR-01-028 (H6)	Ordinary watercourse	Grand Union Canal, Braunston to Leamington Spa (GB70910511) Good potential	Good potential	Moderate	-	-	-	Will not be crossed by the route.

Appendix WR-002-017 | Baseline data

Water feature ¹	Location description (map reference ²)	Watercourse classification ³	Water Framework Directive (WFD) Water Body and overall status	WFD status objective (by 2027 ⁴ as per River Basin Management Plan (RBMP ⁵), unless stated)	Receptor value ⁶	Q95 ⁷	Catchment	Size	Notes
Tributary of River Leam	At Longhole Bridge 95m south-west of the route Map WR-01-028 (H6)	Ordinary watercourse	River Leam – confluence River Itchen to confluence River Avon (GB109054044140) Moderate Status	Good status	Moderate	-	River Avon	-	Will not be crossed by the route.
Drain	Feeder drain to Grand Union Canal 170m south-west of the route Map WR-01-028 (H6)	Ordinary watercourse	Grand Union Canal, Braunston to Leamington Spa (GB70910511) Good potential	Good potential	Moderate	-	Grand Union Canal	-	Will not be crossed by the route.
Watercourse	Upstream of Foose Wharf Farm 665m south-west of the route Map WR-01-028 (G7)	Ordinary watercourse	Grand Union Canal, Braunston to Leamington Spa (GB70910511) Good potential	Good potential	Moderate	-	Grand Union Canal	-	Will not be crossed by the route.
Reservoir	Reservoir at Burnt Firs, will be crossed by the route Map WR-01-028 (F6) (SWC-CFA17-003)	Not applicable	Not applicable	Not applicable	Moderate	-	-	-	

Water feature ¹	Location description (map reference ²)	Watercourse classification ³	Water Framework Directive (WFD) Water Body and overall status	WFD status objective (by 2027 ⁴ as per River Basin Management Plan (RBMP ⁵), unless stated)	Receptor value ⁶	Q95 ⁷	Catchment	Size	Notes
Tributary of River Leam	At Fosseyway Cottage 855m south-west of the route Map WR-01-028 (F7)	Ordinary watercourse	River Leam – confluence River Itchen to confluence River Avon (GB109054044140) Moderate status	Good status	Moderate	-	River Avon	-	Will not be crossed by the route.
Tributary of River Leam	At Osier Cottage 700m south-west of the route Map WR-01-028 (E6)	Ordinary watercourse	River Leam – confluence River Itchen to confluence River Avon (GB109054044140) Moderate status	Good status	Moderate	-	River Avon	-	Will not be crossed by the route.
Tributary of River Leam	At Manor Farm 425m south-west of the route Map WR-01-028 (E6)	Ordinary watercourse	River Leam – confluence River Itchen to confluence River Avon (GB109054044140) Moderate status	Good status	Moderate	-	River Avon	-	Will not be crossed by the route.
Tributary of River Leam	At Hunningham Road – Ash Beds, will be crossed by the route Map WR-01-028 (E5) (SWC-CFA17-004)	Ordinary watercourse	River Leam – confluence River Itchen to confluence River Avon (GB109054044140) Moderate status	Good status	Moderate	0.002m ³ /s	River Avon	2.39 km ²	Flow data obtained through the Flood Estimation Handbook (FEH) CD ROM version 3.0 (NERC – Centre for Ecology & Hydrology©) and Low Flows version 2.0 (Wallingford HydroSolutions Ltd ©).

Appendix WR-002-017 | Baseline data

Water feature ¹	Location description (map reference ²)	Watercourse classification ³	Water Framework Directive (WFD) Water Body and overall status	WFD status objective (by 2027 ⁴ as per River Basin Management Plan (RBMP ⁵), unless stated)	Receptor value ⁶	Q95 ⁷	Catchment	Size	Notes
Tributary of River Leam	North-east of Fields Farm 790m north-east of the route Map WR-01-028 (D4)	Ordinary watercourse	River Leam – confluence River Itchen to confluence River Avon (GB109054044140) Moderate status	Good status	Moderate	-	River Avon	-	Will not be crossed by the route.
River Leam	At Lower Grange, will be crossed by the route Map WR-01-028 (D5) (SWC-CFA17-005)	Main River	River Leam – confluence River Itchen to confluence River Avon (GB109054044140) Moderate status	Good status	High	0.238m ³ /s	River Avon	300km ²	Flow sourced from National River Flow Archive (NRFA) gauged data. Gauging station is upstream of crossing point.
Tributary of River Leam	At Bridge Farm 470m north-east of the route Map WR-01-028 (D4)	Ordinary watercourse	River Leam – confluence River Itchen to confluence River Avon (GB109054044140) Moderate status	Good status	Moderate	-	River Avon	-	Will not be crossed by the route.
Tributary of River Leam	At Lower Grange 280m south-west of the route Map WR-01-028 (C5)	Ordinary watercourse	River Leam – confluence River Itchen to confluence River Avon (GB109054044140) Moderate status	Good status	Moderate	-	River Avon	-	Will not be crossed by the route.
Tributary of River Leam	At Weston Hall Farm 710m north-east of the route Map WR-01-028 (B3)	Ordinary watercourse	River Leam – confluence River Itchen to confluence River Avon (GB109054044140) Moderate status	Good status	Moderate	-	River Avon	-	Will not be crossed by the route.

Water feature ¹	Location description (map reference ²)	Watercourse classification ³	Water Framework Directive (WFD) Water Body and overall status	WFD status objective (by 2027 ⁴ as per River Basin Management Plan (RBMP ⁵), unless stated)	Receptor value ⁶	Q95 ⁷	Catchment	Size	Notes
Tributary of River Leam	West of South Cubbington Wood 290m south-west of the route Map WR-01-028 (B5)	Ordinary watercourse	River Leam – confluence River Itchen to confluence River Avon (GB109054044140) Moderate status	Good status	Moderate	-	River Avon	-	Will not be crossed by the route.
Tributary of River Avon	At Furzen Hill Farm – Coventry Road 280m north-east of the route Map WR-01-028 (A4)	Ordinary watercourse	River Avon – Clay Coton Yelvertoft Brook to confluence River Sowe (GB109054043920) Poor status	Good status	Moderate	-	River Avon	-	Will not be crossed by the route.
Drain	In Weston Woods 340m north-east of the route Map WR-01-028 (A4)	Ordinary watercourse	River Avon – Clay Coton Yelvertoft Brook to confluence River Sowe (GB109054043920) Poor status	Good status	Moderate	-	River Avon	-	Will not be crossed by the route.
Tributary of River Avon	At Cotton Mill Spinney 450m south-west of the route Map WR-01-028 (A5)	Ordinary watercourse	River Avon – Clay Coton Yelvertoft Brook to confluence River Sowe (GB109054043920) Poor status	Good status	Moderate	-	River Avon	-	Will not be crossed by the route.

3.2.3 Table 2 summarises licensed surface water abstractions within 1km of the route⁸. Information from Warwick District Council which indicates that there are no unlicensed abstractions from surface water used for potable supply in their records.

Table 2: Licensed surface water abstractions

Licence identifier (map reference number ⁹ and Environment Agency reference)	Distance from route	Abstraction source	Maximum annual abstraction quantity	Maximum daily abstraction quantity	Purpose
18/54/12/0096/S Map WR-01-028 (F6)	75m north-east of the route	Burnt Heath Farm, Offchurch – Spring/drains fed reservoir	18,184m ³	1,818.4m ³	Agriculture

3.2.4 Table 3 summarises surface water discharge consents within 1km of the route.

Table 3: Permitted discharges to surface water

Reference number	Permit identifier	Distance from route	Discharge type	Receiving water body
14200974 Map WR-01-028 (F7)	S/12/25645/S	855m south-west of the route	Sewage discharge	Tributary of River Leam.
8899973 Map WR-01-028 (F7)	S/12/25616/S	855m south-west of the route	Sewage discharge	Ditch/Tributary of River Leam.
1476552 Map WR-01-028 (F7)	S/12/22493/S	850m south-west of the route	Sewage discharge	Tributary of River Leam.
20358118 Map WR-01-028 (D6)	S/12/25927/S	770m south-west of the route	Sewage discharge	Tributary of River Leam.
19448937 Map WR-01-028 (D6)	S/12/25927/S	770m south-west of the route	Sewage discharge	Tributary of River Leam.
20358439 Map WR-01-028 (D6)	S/12/25927/S	770m south-west of the route	Sewage discharge	Tributary of River Leam.
1476629 Map WR-01-028 (D6)	CS/12/23240/S/1	730m south-west of the route	Sewage discharge	Receiving water body not defined in Environment Agency data.
1476570 Map WR-01-028 (D6)	S/12/23240/S	725m south-west of the route	Sewage discharge	Tributary of River Leam.
1476630 Map WR-01-028 (C6)	S/12/23202/S	475m south-west of the route	Sewage discharge	Tributary of River Leam.
20358565 Map WR-01-028 (B4)	S/12/25786/S	265m north-east of the route	Sewage discharge	Tributary of River Leam.
14200970 Map WR-01-028 (B4)	S/12/25786/S	265m north-east of the route	Sewage discharge	Tributary of River Leam.
14201059 Map WR-01-028 (B4)	S/12/25791/S	290m north-east of the route	Sewage discharge	Tributary of River Leam.

⁸ Surface water abstractions for public supply are not included.

⁹ Map references taken from Volume 5: Map Book – Water resource Maps WR-01-028 and WR-01-029.

3.3 Groundwater

- 3.3.1 The majority of the groundwater within the study area lies within the Warwickshire Avon – Secondary Mudrocks (GB40902G990900) water body. The north-west of the study area lies within the Warwickshire Avon PT Sandstone Warwick/Avon confined (GB40901G300700) water body (see Volume 5: Maps WR-03-028 and WR-03-029).
- 3.3.2 Several superficial aquifers are located within this study area. These are: alluvium, Dunsmore Gravel, Wolston Sand and Gravel, river terrace deposits 1 and 2 and Baginton Sand and Gravel which are all designated as Secondary A aquifers. They are currently of good chemical and quantitative quality and are predicted to remain at good chemical and quantitative quality by 2015. These aquifers are of moderate value.
- 3.3.3 The underlying bedrock aquifer comprised of Mercia Mudstone Group-Mudstone is designated as a Secondary B aquifer. This is currently of good chemical and quantitative quality and is predicted to remain at good chemical and quantitative quality by 2015. This aquifer is of moderate value.
- 3.3.4 Strata not discussed above are considered to be unproductive by the Environment Agency.
- 3.3.5 The following table summarises licensed groundwater abstractions within the study area (see Volume 5: Map WR-02-017).
- 3.3.6 No private water supplies have been identified by Warwick District Council within the study area.

Table 4: Licensed groundwater abstractions

Licence identifier (map reference number ¹⁰ and Environment Agency reference)	Distance from route	Abstraction horizon	Maximum annual abstraction quantity	Maximum daily abstraction quantity	Number of boreholes	Purpose
18/54/12/0017 Map WR-02-017 (F4) Located 2km north-east of River Leam viaduct	1,200m north-east of the route at Toe Hill	Likely to be from Mercia Mudstone Group	8,296 m ³	22.72 m ³	1	Agriculture- General farming and domestic

- 3.3.7 The following table summarises groundwater discharge permits within 1km of the study area.

¹⁰ Map references taken from Volume 5: Map Book – Water resources, Map WR-02-017.

Table 5: Groundwater discharge permits

Reference number and map reference ¹¹	Permit identifier	Distance from route	Discharge type	Receiving water body
WQ/72/439/1 Map WR-02-017 (E5) Located 1.8km north-west of River Leam viaduct	1476549	585m east of the route (Weston Hall Farm)	Sewage discharge	Groundwater Warwickshire Avon – Secondary Mudrocks (GB40902G990900)
WQ/72/420/1 Map WR-02-017 (F6) Located 1.1km south-east of River Leam viaduct	1476546	790m south-west of the route (Ham Barn)	Sewage discharge	Groundwater Warwickshire Avon – Secondary Mudrocks (GB40902G990900)

Groundwater/surface water interaction

3.3.8 Table 6 summarises springs, sinks and issues (locations where groundwater rises to the surface in a more diffuse way than at a spring) within the study area. Due to the number of ponds and other water features present within the study area, only those either within the land required for the constriction or operation of the scheme, or within the calculated zone of influence, are included in Table 6.

Table 6: Groundwater/surface water interaction

Location description and map reference ¹²	Distance from route	Formation	Elevation	Comments
Issues 1.7km north of Ufton. Located on southern side of Grand Union Canal at crossing with track called 'Ridgeway Lane' Map WR-02-017 (H5), 200m north of Longhole viaduct	180m south-west of the route	Alluvium superficial deposits underlain by Mercia Mudstone Group	70mAOD	May receive groundwater from Alluvium
Issues located at Print Farm, 2.3km north-east of Ufton Map WR-02-017 (H5), 500m north of Longhole viaduct	650m north-east of the route	Alluvium superficial deposits underlain by Mercia Mudstone Group	70mAOD	May receive groundwater from Alluvium
Issues at Fossey Cottage, 1km south east of Offchurch Map WR-02-017 (G6), 2.0km south-west of Longhole viaduct	870m south-west of the route	Alluvium superficial deposits underlain by Mercia Mudstone Group	70mAOD	May receive groundwater from Alluvium
Sinks and Issues located in Sutton Spinney, 1.3km east of Offchurch Map WR-02-017 (F5), 2.2km west of Longhole viaduct	140m north-east of the route	Wolston Sand and Gravel and alluvial superficial deposits underlain by Mercia Mudstone Group	90mAOD	Culvert or pipe likely to be present between the sinks and issues

¹¹ Map references taken from Volume 5: Map Book – Water resources, Map WR-02-017.

¹² Map references taken from Volume 5: Map Book – Water resource Map WR-02-017 and maps in Volume 5: Map Book – Ecology Map EC-04-046.

Location description and map reference ¹²	Distance from route	Formation	Elevation	Comments
<p>Unnamed watercourse runs through Ash Beds woodland area</p> <p>Map WR-02-017 (F5), 990m south of the River Leam viaduct</p>	Will be crossed by the route	Alluvium underlain by Mercia Mudstone Group	Not applicable	May receive groundwater from Alluvium
<p>Issues located at corner of field, 500m east of Offchurch</p> <p>Map WR-02-017 (F6), 1.5km south-west of River Leam viaduct</p>	300m south-west of the route	Mercia Mudstone Group	75mAOD	Groundwater may be from Mercia Mudstone Group
<p>River Leam</p> <p>Map WR-02-017 (E5), will be crossed by River Leam viaduct</p>	Will be crossed by the route	Alluvium underlain by Mercia Mudstone Group	Not applicable	Likely to receive groundwater from underlying Secondary Aquifers
<p>Issues located in Offchurch, at Smithy Cottages</p> <p>Map WR-02-017 (F5), 1.6km south-west of River Leam viaduct</p>	670m south-west of the route	Thrussington Member superficial deposits composed of diamicton till underlain by the Mercia Mudstone Group	65mAOD	Groundwater may be from superficial Secondary A deposits underlying the diamicton or possibly from a minor permeable unit within the till
<p>Issues located 400m north east of Fields Farm, north-east of Offchurch</p> <p>Map WR-02-017 (E6), 1.2km south-east of River Leam viaduct</p>	790m north-east of the route	Mercia Mudstone Group	75mAOD	May receive groundwater from Mercia Mudstone Group
<p>Spring located 280m east of Lower Grange Farm, south-west of Cubbington</p> <p>Map WR-02-017 (E6), 280m west of River Leam viaduct</p>	300m south-west of the route	Mercia Mudstone Group	85mAOD	May receive groundwater from Mercia Mudstone Group (potentially from boundary between Secondary A superficial deposits and bedrock aquifer)
<p>Issues located 380m south east of Glebe House, Weston under Wetherley</p> <p>Map WR-02-017 (E5), 1.4km north-west of River Leam viaduct</p>	1,100m north-east of the route	River terrace deposits composed of sand and gravel underlain by Mercia Mudstone Group	70mAOD	May receive groundwater from river terrace deposits
<p>Issues located in Cubbington, between Prince Road and Ladycroft</p> <p>Map WR-02-017 (E6), 1.4km north-west of River Leam viaduct</p>	890m south-west of the route	Mercia Mudstone Group	90mAOD	May receive groundwater from Mercia Mudstone Group, issues are within a residential area

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Location description and map reference ¹²	Distance from route	Formation	Elevation	Comments
Sinks located 260m south east of Glebe House, Weston under Wetherley Map WR-02-17 (E5), 1.4km north-west of River Leam viaduct	1,100m north-east of the route	River terrace deposits composed of sand and gravel underlain by Mercia Mudstone Group.	75mAOD	Water enters groundwater within the river terrace deposits
Issues at Weston Hall Farm, 500m south west of Weston under Wetherley Map WR-02-017 (E5), 1.63km north-east of River Leam viaduct by South Cubbington Woods	700m north-east of the route	Mercia Mudstone Group.	80mAOD	May receive groundwater from Mercia Mudstone Group
Issues situated on B4153 between Cubbington and South Cubbington Woods Map WR-02-017 (E6), 1.3km north-west of River Leam viaduct, located in Cubbington	300m south-west of the route	Mercia Mudstone Group.	90mAOD	Groundwater appears to be from the Mercia Mudstone Group
Pond located 380m south of Weston Hall Map EC-04-046 (H6) 1.4km north of River Leam viaduct	430m east of the route	Thrussington Member superficial deposits composed of diamicton underlain by the Mercia Mudstone.	90mAOD	Located on Unproductive strata and on elevated topography compared to the surrounding land therefore unlikely to be groundwater dependent
Pond located 750m south-west of Weston Hall Map EC-04-046 (F7) 1.1km north-west of River Leam viaduct	115m west of the route	Thrussington Member superficial deposits composed of diamicton underlain by the Mercia Mudstone.	95mAOD	Located on Unproductive strata and on elevated topography compared to the surrounding land therefore unlikely to be groundwater dependent
Sinks and Issues located 280m north of Weston under Wetherley Map WR-02-017(E4) 1.4km north-east of River Leam viaduct	1,500m north-east of the route	Mercia Mudstone Group.	75mAOD	Sinks and Issues are a culvert and therefore not likely to be groundwater dependent
Drain, located on the south-western corner of North Cubbington Woods Map WR-02-017 (E5), 1.6km north-west of River Leam viaduct	205m east of the route	Diamicton till underlain by Mercia Mudstone Group.	95mAOD	Located on Unproductive strata therefore unlikely to be groundwater dependent
Issues located 520m south east of Furzen Hill Farm, north of Cubbington Map WR-02-017 (D5) 2.3km north-west of River Leam viaduct	440m north-east of the route	Mercia Mudstone Group.	85mAOD	Groundwater may be from Mercia Mudstone Group (potentially from boundary between superficial Secondary A deposits and bedrock)

Location description and map reference ¹²	Distance from route	Formation	Elevation	Comments
Issues located 150m north-west of Oakdene, Cubbington Map WR-02-017 (D6) 1.6km north-west of River Leam viaduct	480m south-west of the route	Alluvium superficial deposits underlain by Mercia Mudstone Group	75mAOD	May receive groundwater from alluvium
Reservoir at Burnt Firs	Refer to Table 7			
Two ponds within Sutton Spinney, 1km east of Cubbington Map WR-02-017 (F5) 1.9km south-east of River Leam viaduct	140m east of the route	Wolston Sand and Gravel superficial deposits underlain by Mercia Mudstone Group	90mAOD	May receive groundwater from Wolston Sand and Gravel
Surface water drain flowing west Map WR-02-017 (F5) 1.8km south-east of River Leam viaduct	130m east of the route	Wolston Sand and Gravel superficial deposits underlain by Mercia Mudstone Group	90mAOD	May receive groundwater from Wolston Sand and Gravel

Water dependent habitats

3.3.9 The following table summarises the potential water dependent habitats within the study area. These have been identified from a review of Ordnance Survey (OS) mapping, aerial photography and from the following sources:

- Information on designated and potential non-statutory Local Wildlife Sites (LWS) from Warwickshire Biological Records Centre;
- Information on statutory designated sites from Natural England;
- Information from ecological surveys carried out in support of the Environmental Impact Assessment (EIA).

3.3.10 The table identifies where a water dependency may exist but the assessment of impact on water dependent ecology receptors is found in Volume 2, CFA Report 17, Section 7.

Table 7: Description of water dependent habitats

Location and map reference ¹³	Distance from route	Designation	Comments
Fosse Wood which runs alongside an unnamed tributary of the River Leam Map EC-01-044b (E6) will be crossed by Longhole viaduct	Will be crossed by the route	Potential LWS, identified as a wet habitat by Ecology	Most likely surface water dependent

¹³ Map references taken from Volume 5: Map Book – Ecology, Maps EC-01-44b to EC-01-46.

Location and map reference ¹³	Distance from route	Designation	Comments
The River Leam Map EC-01-045 (A6) will be crossed by River Leam viaduct	Will be crossed by the route	Potential LWS	May be groundwater and surface water dependent
Ash Beds Map EC-01-045 (D6) located 20m north of Hunningham Road overbridge	Will be crossed by the route	Potential LWS	Likely to surface water dependent as it is woodland that follows an unnamed tributary of the River Leam
South Cubbington Wood LWS Map EC-01-046, (F6) located 100m south of B4453 Rugby Road overbridge	Will be crossed by the route	Ancient woodland, LWS	No evidence that site is dependent on groundwater
Weston and Waverly Wood LWS Map EC-01-046, (C2) located 700m east of Coventry Road overbridge	Lies 650m to the east of the route	Ancient woodland, LWS	May be surface water and groundwater dependent

3.4 Site-specific assessments

Surface water

3.4.1 Table 8 summarises the potential impacts and effects to surface water.

Table 8: Summary of potential impacts to surface water

Surface water feature/receptor ¹⁴	Value of surface water feature ¹⁵	Design element	Magnitude of impact (no mitigation)	Potential impact to water resource	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Tributary of River Leam at Longhole Bridge (SWC-CFA17-001) Map WR-01-028 (H6)	Moderate	Watercourse to be realigned around viaduct abutment Drainage outfall Balancing pond Grand Union Canal embankment	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; and Through uncontrolled site run-off.	Adoption of Environment Agency Pollution Prevention Guidelines (PPGs) – particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

¹⁴ Map references taken from Volume 5: Map Book – Water resources Maps WR-01-028 and WR-01-029.¹⁵ For examples of receptor value see Table 43 in the SMR addendum Volume 5 Appendix CT-001-000/2.

Surface water feature/receptor ¹⁴	Value of surface water feature ¹⁵	Design element	Magnitude of impact (no mitigation)	Potential impact to water resource	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		Drainage outfall (from railway)	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the proposed railway and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the proposed railway. Balancing pond before outfall to watercourse to restrict run-off rates and reduce the effect on water quality by reducing potential contaminants through filtration, vegetative absorption or settlement.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
		Watercourse realignment around viaduct embankment	Moderate adverse	Deterioration or loss of the existing water environment, flows and the ecology supported.	Opportunities will be taken to retain and if possible enhance the overall quality of the watercourse, for example by including meanders and enhanced banks.	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	None required	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	Construction (Permanent)

Surface water feature/receptor ¹⁴	Value of surface water feature ¹⁵	Design element	Magnitude of impact (no mitigation)	Potential impact to water resource	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		All elements (maintenance)	Moderate adverse	Deterioration of water quality due to contamination from de-icing substances used during cold weather and herbicides for managing vegetation on the tracks.	Best practice pollution control guidance will be adopted for maintenance of the Proposed Scheme.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Operation
Grand Union Canal at Longhole Bridge (SWC-CFA17-002) Map WR-01-028 (H6)	High	Longhole viaduct. Realigned Welsh Road highways drainage to outfall to Grand Union Canal via pipe Drainage outfall Balancing pond Grand Union Canal embankment Ditch to connect to realigned Welsh Road highways drainage – assumed drainage outfall to Grand Union Canal receptor	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; and Through uncontrolled site run-off.	Adoption of Environment Agency PPGs – particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

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Surface water feature/receptor ¹⁴	Value of surface water feature ¹⁵	Design element	Magnitude of impact (no mitigation)	Potential impact to water resource	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		Drainage outfall (from railway)	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the proposed railway and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the railway. Balancing pond before outfall to watercourse to restrict run-off rates and reduce the effect on water quality by reducing potential contaminants through filtration, vegetative absorption or settlement.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
		Drainage outfall (from Welsh Road realignment)	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the railway and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the road.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)

Surface water feature/receptor ¹⁴	Value of surface water feature ¹⁵	Design element	Magnitude of impact (no mitigation)	Potential impact to water resource	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		All elements (maintenance)	Moderate adverse	Deterioration of water quality due to contamination from de-icing substances used during cold weather and herbicides for managing vegetation on the tracks.	Best practice pollution control guidance will be adopted for maintenance of the Proposed Scheme.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Operation
Reservoir at Burnt Firs (SWC-CFA17-003) Map WR-01-028 (F6)	Moderate	Existing reservoir to be drained and backfilled Embankment	Major adverse	Loss of reservoir for winter storage of abstracted water.	None required	Major Large (Significant)	None required	Major Large (Significant)	Construction (Permanent)
Tributary of River Leam at Hunningham Road – Ash Beds (SWC-CFA17-004) Map WR-01-028 (E5)	Moderate	Ash Beds culvert Embankment Realigned Hunningham Road and associated drainage outfall to Ash Beds Drainage outfall Balancing pond	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; and Through uncontrolled site run-off.	Adoption of Environment Agency PPGs – particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature/receptor ¹⁴	Value of surface water feature ¹⁵	Design element	Magnitude of impact (no mitigation)	Potential impact to water resource	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		Ash Beds culvert	Moderate adverse	Culvert may impact on the existing water environment, potentially changing flow characteristics and the ecology supported.	Improvements along watercourse either side of culvert, to mitigate loss of open length.	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	None required	Minor to Minor Beneficial Slight to Slight Beneficial (not significant)	Construction (Permanent)
		Drainage outfall (from railway)	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the proposed railway and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the proposed railway. Balancing pond before outfall to watercourse to restrict run-off rates and limit the effect on water quality by reducing potential contaminants through filtration, vegetative absorption or settlement.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)

Surface water feature/receptor ¹⁴	Value of surface water feature ¹⁵	Design element	Magnitude of impact (no mitigation)	Potential impact to water resource	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		Drainage outfall (from Hunningham Road)	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the road and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the road.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
		All elements (maintenance)	Moderate adverse	Deterioration of water quality due to contamination from de-icing substances used during cold weather and herbicides for managing vegetation on the tracks.	Best practice pollution control guidance will be adopted for maintenance of the Proposed Scheme.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Operation

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Surface water feature/receptor ¹⁴	Value of surface water feature ¹⁵	Design element	Magnitude of impact (no mitigation)	Potential impact to water resource	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
River Leam at Lower Grange (SWC-CFA17-005) Map WR-01-028 (D5)	High	River Leam viaduct Embankment Realignment of B4453 Rugby Road Drainage outfalls Balancing ponds	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; and Through uncontrolled site run-off.	Adoption of Environment Agency PPGs – particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature/receptor ¹⁴	Value of surface water feature ¹⁵	Design element	Magnitude of impact (no mitigation)	Potential impact to water resource	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		Drainage outfalls (from railway)	Moderate adverse	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the proposed railway and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the proposed railway. Balancing pond before outfall to watercourse to restrict run-off rates and limit the effect on water quality by reducing potential contaminants through filtration, vegetative absorption or settlement.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
		Drainage outfall (from realignment of B4453 Rugby Road – highway drainage to connect to railway drainage – assumed drainage to River Leam)	Moderate (adverse)	Impact on flows in the receiving watercourse. Deterioration of water quality due to contamination of surface water from both routine discharges from the road and associated infrastructure or from accidental spillages.	Drainage has been designed to reduce the rate and volume of run-off from the road. Balancing pond before outfall to watercourse to restrict run-off rates and limit the effect on water quality by reducing potential contaminants through filtration, vegetative absorption or settlement.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)

Surface water feature/receptor ¹⁴	Value of surface water feature ¹⁵	Design element	Magnitude of impact (no mitigation)	Potential impact to water resource	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
		All elements (maintenance)	Moderate adverse	Deterioration of water quality due to contamination from de-icing substances used during cold weather and herbicides for managing vegetation on the tracks.	Best practice pollution control guidance will be adopted for maintenance of the Proposed Scheme.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Operation
Tributary of River Avon at Furzen Hill Farm – Coventry Road (note Main River Avon not within this CFA – within Stoneleigh, Kenilworth and Burton Green CFA18). Map WR-01-028 (A4)	Moderate	Realigned Coventry Road Linear soakaways for highway drainage	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; and Through uncontrolled site run-off.	Adoption of Environment Agency PPGs – particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Surface water feature/receptor ¹⁴	Value of surface water feature ¹⁵	Design element	Magnitude of impact (no mitigation)	Potential impact to water resource	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Drain in Weston Woods (note that this eventually drains to the River Avon which is not within this CFA – within Stoneleigh, Kenilworth and Burton Green CFA18) Map WR-01-028 (A4)	Moderate	Realigned Coventry Road Linear soakaways for highway drainage	Moderate adverse	Deterioration of water quality due to: Deposition of soils, sediment and other construction materials, and spillage of fuels and other hazardous liquids; The mobilisation of contaminants following disturbance of contaminated ground or groundwater; and Through uncontrolled site run-off.	Adoption of Environment Agency PPGs – particularly PPG5 for in-channel works. Mitigation measures outlined in draft CoCP. Water management implemented during earthworks operation. Temporary site drainage designed to retain surface run-off within site boundary. Grey water systems used at construction compounds.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Temporary)

Groundwater

3.4.2 Following the methodology outlined in the SMR addendum (see Volume 5: Appendix CT-001-000/2), the hydraulic conductivity values; obtained from available literature values, were used in conjunction with professional judgment to estimate the maximum extent of the zone of influence that is likely to be produced when dewatering of a cutting occurs. The hydraulic conductivity values used are generally in the high range of literature values to provide a realistic factor of safety to the estimated zone of influence. Based on this worst case assumption, the zone of influence is likely to be overestimated, however for the purpose of this preliminary assessment, this approach is considered to be acceptable.

3.4.3 Aquifer properties used for estimating the zone of influence can be found in Table 9.

Table 9: Aquifer properties

Lithology	Maximum hydraulic conductivity value used in calculation	References
Mercia Mudstone Group-Mudstone and Dolomitic siltstone	0.1m/d	Tellam and Lloyd ¹⁶
Bromsgrove Sandstone Formation	2.71m/d	BGS Aquifers Properties Manual ¹⁷
Alluvium	864m/d	Hiscock 2005 ¹⁸
River Terrace Deposits	51.8m/d	An average of sand values from Domenico and Schwartz 1990 ¹⁹
Glaciofluvial Deposits Sand and Gravel	86.4m/d	Hiscock 2005
Glaciolacustrine Deposits – clay and silt	0.0000864m/d	Hiscock 2005
Head Deposits	0.173m/d	Domenico, PA and FW Schwartz, 1990

3.4.4 The zone of influence for the dewatering of the cuttings along the route was calculated at frequent intervals as topography, geology and track level will change, using the methodology outlined in the SMR addendum (see Volume 5: Appendix CT-001-000/2) and the properties in Table 9. Table 10 summarises the estimated zone of influence within the study area for each of the cuttings. In each case, the maximum zone of influence value reported has not been applied to the whole extent of the cutting; it is purely illustrative of the worst-case conditions at its deepest section.

¹⁶ Tellam J.H. and Lloyd J.W. (1981), A review of the hydrogeology of British onshore non-carbonate mudrocks. *Quarterly Journal of Engineering Geology and Hydrogeology* 1981, v.14; pp347-355.

¹⁷ British Geological Survey (1997), *The Physical Properties of Major Aquifers in England and Wales*. p199.

¹⁸ Hiscock, K.M. (2005), *Hydrogeology: Principles and Practice*, Blackwell Science Ltd, Oxford.

¹⁹ Domenico, P.A. and F.W. Schwartz (1990), *Physical and Chemical Hydrogeology*, John Wiley & Sons, New York.

Table 10: Maximum extent of zone of influence in CFA17

Cutting	Geology	Maximum drawdown within cutting	Maximum zone of influence estimated from maximum drawdown	Comments
Offchurch cutting	Mercia Mudstone Group – Mudstone (Bedrock)	16m	51.64m	
	Wolston clays and silts	5m	0.47m	
	Wolston sand and gravel	4m	293.94m	
	Dunsmore Gravel	4m	293.94m	
	Thrussington Member Diamicton	4m	16.97m	
	Bagington Sand and Gravel Formation	2m	146.97m	
Ash Beds cutting	River Terrace Deposits	0.2m	14.70m	
Lower Grange cutting	Bagington Sand and Gravel	2m	146.97m	
Cubbington retaining wall	Mercia Mudstone Group Mudstone (Bedrock)	9m	29.05m	
	Wolston Clays and Silts	9m	0.85m	
	Wolston sand and gravels	5m	367.42m	
	Thrussington Member	7m	29.70m	
	Dunsmore Sand and Gravel	2m	146.97m	
Cubbington cutting	Mercia Mudstone Group – Dolomitic Siltstone	2m	6.45m	
	Mercia Mudstone Group – Mudstone	3m	9.68m	
	Bagington Sand and Gravel Formation	1m	73.48m	
	Wolston Clays and Silt	5m	0.47m	
	Thrussington member diamicton	7m	29.70m	
	Dunsmore Sand and Gravel	2m	146.97m	

3.4.5 Table 11 summarises the potential impacts to groundwater, abstractions, water dependent habitats and groundwater/ surface water interactions.

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Table 11: Summary of potential impacts to groundwater, abstractions, water dependent habitats and groundwater/ surface water interactions

Groundwater receptor ²⁰ (and value) ²¹	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Aquifers								
Bedrock Aquifer, Principal aquifer in Bromsgrove Sandstone Formation (high)	Cubbington cutting	Minor adverse	Dewatering could reduce groundwater levels in the aquifer. Potential for contaminants to enter the groundwater during construction (e.g. suspended solids, leaks from machinery).	Sustainable drainage systems (SuDS) such as infiltration trenches will be located where feasible to facilitate groundwater recharge. Contamination control measures as required by the draft CoCP Section 16.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
Bedrock Aquifer, Secondary B aquifer in Mercia Mudstone (moderate)	Various including: Lower Grange cutting; Offchurch cutting; Cubbington retaining wall; Longhole viaduct; and River Leam viaduct.	Moderate adverse	Dewatering could reduce groundwater levels in the aquifer. Potential for contaminants to enter the groundwater during construction (e.g. suspended solids, leaks from machinery).	SuDS such as infiltration trenches will be located where feasible to facilitate groundwater recharge. Contamination control measures as required by the draft CoCP Section 16.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)

²⁰ Map references taken from Volume 5: Map Book – Water resources, Map WR-02-017 and Volume 5: Map Book – Ecology, Maps EC-01 to EC-04.

²¹ For examples of receptor value see Table 43 in the SMR addendum Volume 5 Appendix CT-001-000/2.

Groundwater receptor ²⁰ (and value) ²¹	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Superficial Aquifer, Secondary A aquifer in Alluvium (moderate)	Various including: Worksites; River Leam viaduct; Longhole viaduct; and Fosse Way construction compound.	Moderate adverse	Dewatering required to construct viaduct foundations could reduce groundwater levels in the aquifer. Foundations required for viaducts could alter groundwater flow regime, however this will be a negligible impact.	SuDS such as infiltration trenches will be located where feasible to facilitate groundwater recharge.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
Superficial Aquifer, Secondary A aquifer in Dunsmore Gravel (moderate)	Various including: Offchurch cutting; Cubbington retaining wall; Stockpile; and Construction compound.	Major adverse	Dewatering could reduce groundwater levels in the aquifer. Reduced infiltration could reduce groundwater levels.	SuDS such as infiltration trenches will be located where feasible to facilitate groundwater recharge.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)

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Groundwater receptor ²⁰ (and value) ²¹	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Superficial aquifer, Secondary A aquifer in Wolston Sand and Gravel (moderate)	Various including: Offchurch cutting; and Cubbington retaining wall.	Major adverse	Dewatering could reduce groundwater levels in the aquifer. Potential for contaminant to enter the groundwater during construction (e.g. suspended solids, leaks from machinery).	SuDS such as infiltration trenches will be located where feasible to facilitate groundwater recharge.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
Superficial aquifer, Secondary A aquifer in river terrace deposits (moderate)	Various including: Longhole viaduct; and River Leam viaduct.	Moderate adverse	Reduced infiltration could reduce groundwater levels. Foundations required for viaducts have potential to alter groundwater flow regime.	SuDS such as infiltration trenches will be located where feasible to facilitate groundwater recharge.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
Superficial aquifer, Secondary A aquifer in Bagington Sand and Gravel Formation (moderate)	Various including: Cubbington retaining wall.	Major adverse	Dewatering could reduce groundwater levels.	SuDS such as infiltration trenches will be located where feasible to facilitate groundwater recharge.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
Abstractions								
18/54/12/0017 Map WR-02-017 (F4) Location: 2.0km north-east of River Leam viaduct	Ash Beds cutting	Negligible	Not within the zone of influence and therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

Groundwater receptor ²⁰ (and value) ²¹)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Water dependent habitat								
Fosse Wood which runs alongside an unnamed tributary of the River Leam (moderate) Map EC-01-044b (E6)	Longhole viaduct	Minor adverse	Dewatering could reduce groundwater levels which may have an adverse impact on the deciduous woodland that runs alongside the canal.	SuDS in the form of infiltration trenches located at the southern end of Offchurch Cutting to facilitate groundwater recharge. Contamination control measures as required by the draft CoCP Section 16.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
Burnt Firs (moderate) Map EC-01-045 (H6)	Offchurch cutting	Negligible (Note loss of reservoir addressed in surface water and Ecology Volume2 Section7).	Remaining woodland unlikely to be groundwater dependent therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
The River Leam (moderate) Map EC-01-045 (A6)	River Leam viaduct	Minor adverse	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater. However it may receive impacts from the reduction in infiltration due to earthworks and landscaping either side of the river.	SuDS and balancing ponds to be located within the vicinity of River Leam viaduct to facilitate recharge to the groundwater. Contamination control measures as required by the draft CoCP Section 16.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)

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Groundwater receptor ²⁰ (and value) ²¹	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Ash Beds (moderate) Map EC-01-045 (D6)	Ash Beds cutting	Minor adverse	Dewatering could reduce groundwater levels at receptor.	Watercourse is to be culverted to maintain its flow and effects from any changes in groundwater should be minimal. Contamination control measures as required by the draft CoCP Section 16.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)
South Cubbington Wood (high) Map EC-01-046, (F6)	Cubbington retaining wall	Negligible	Located within the zone of influence however not considered to be water dependent habitat.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Weston and Waverly Wood (high) Map EC-01-046, (C2)	Cubbington cutting	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Surface water and groundwater interaction								
Issues (moderate) 180m south-east of the route Map WR-02-017 (H5), 200m north of Longhole viaduct	Longhole viaduct	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

Groundwater receptor ²⁰ (and value) ²¹	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Issues (moderate) 650m north-east of the route Map WR-02-017 (H5), 500m north of Longhole viaduct	Grand Union embankment	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Reservoir (moderate) Map WR-02-017 (D6), 2.3km south-west of River Leam viaduct	Offchurch cutting	Major adverse	The reservoir is to be removed and infilled and therefore will no longer be present.	Refer to Ecology Volume2, CFA Report 17, Section 7.				
Issues (moderate) 870m south-west of the route Map WR-02-017 (G6), 2.0km south-west of Longhole viaduct	Offchurch cutting	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Sinks and Issues (moderate) 140m north-east of the route Map WR-02-017 (F5), 2.2km west of Longhole viaduct	Offchurch cutting	Negligible	Sinks and issues are located either side of a disused railway therefore are likely to be a culvert and not groundwater dependent therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

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Groundwater receptor ²⁰ (and value) ²¹	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
<p>Unnamed watercourse runs through Ash Beds woodland area.</p> <p>Will be crossed by the route</p> <p>Map WR-02-017 (F5), 990m south of the River Leam viaduct</p>	Offchurch cutting	Negligible	Located on Unproductive strata therefore unlikely to receive adverse impacts from changes to groundwater.	None required	<p>Negligible</p> <p>Neutral</p> <p>(not significant)</p>	None required	<p>Negligible</p> <p>Neutral</p> <p>(not significant)</p>	None
<p>Issues (moderate)</p> <p>300m south-west of the route</p> <p>Map WR-02-017 (F6), 1.5km south-west of River Leam viaduct</p>	Offchurch cutting	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	<p>Negligible</p> <p>Neutral</p> <p>(not significant)</p>	None required	<p>Negligible</p> <p>Neutral</p> <p>(not significant)</p>	None
<p>River Leam</p> <p>Will be crossed by the route</p> <p>Map WR-02-017 (E5), will be crossed by River Leam viaduct</p>	River Leam viaduct	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	<p>Negligible</p> <p>Neutral</p> <p>(not significant)</p>	None required	<p>Negligible</p> <p>Neutral</p> <p>(not significant)</p>	None

Groundwater receptor ²⁰ (and value) ²¹)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Issues (moderate) 670m south-west of the route Map WR-02-017 (F5), 1.6km south-west of River Leam viaduct	Offchurch cutting	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Issues (moderate) 790m north-east of the route Map WR-02-017 (F5), 1.2km south-east of River Leam viaduct	River Leam embankment	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Spring (moderate) 300m south-west of the route Map WR-02-017 (E6), 280m west of River Leam viaduct	Lower Grange embankment	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Issues (moderate) 1.1km north-east of the route Map WR-02-017 (E4), 1.4km north-west of River Leam viaduct	Cubbington retaining wall	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

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Groundwater receptor ²⁰ (and value) ²¹	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Issues (moderate) 890m south-west of the route Map WR-02-017 (E6), 1.4km north west of River Leam viaduct	Cubbington retaining wall	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Sinks (moderate) 1.1km north-east of the route Map WR-02-017 (E4), 1.4km north west of River Leam viaduct	Cubbington retaining wall	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Issues (moderate) 700m north-east of the route Map WR-02-017 (E5), 1.6km north east of River Leam viaduct	Cubbington retaining wall	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

Groundwater receptor ²⁰ (and value) ²¹	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Issues (moderate) 300m south-west of the route Map WR-02-017 (E5), 1.3km north-west of River Leam viaduct	Cubbington retaining wall	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Pond (low) 430m east of the route Map EC-04-046 (H6) 1.4km north of River Leam viaduct	Cubbington retaining wall	Major adverse	Pond assumed to be removed during construction of the Proposed Scheme.	Refer to Ecology Volume2, CFA Report 17, Section 7.				
Pond (low) 115m west of the route MapEC-04-046 (F7) 1.1km north-west of River Leam viaduct	Cubbington retaining wall	Major adverse	Pond assumed to be removed during construction of the Proposed Scheme.	Refer to Ecology Volume2, CFA Report 17, Section 7.				

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Groundwater receptor ²⁰ (and value) ²¹)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Sinks and Issues (moderate) 1.5km north-east of the route MapWR-02-017 (E6), 1.4km north east of River Leam viaduct	Cubbington retaining wall / Cubbington cutting	Negligible	Sinks and Issues have been identified as a culvert. Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	Not required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Issues (moderate) 440m north-east of the route MapWR-02-017 (E4), 2.3km north west of River Leam viaduct	Cubbington cutting	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	Not required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Issues (moderate) 480m south-west of the route MapWR-02-017 (D5), 1.6km north west of River Leam viaduct	Cubbington cutting	Negligible	Not within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater.	Not required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None

Groundwater receptor ²⁰ (and value) ²¹)	Design element	Magnitude of impact (no mitigation)	Potential impact to groundwater	Avoidance and mitigation measures	Magnitude of remaining impact and effect	Other mitigation measures	Residual effect	Duration of effect
Two ponds within Sutton Spinney, around 1km east of Cubbington (low) 140m east of the route Map EC-04-045 (F5), 1.9km south-east of River Leam viaduct	Offchurch cutting Offchurch Greenway overbridge	Moderate adverse	The ponds are partly located within the zone of influence therefore maybe adversely impacted from dewatering.	None required	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	None
Surface water drain flowing west (moderate) 130m east of the route Map WR-02-017 (F5), 1.8km south-east of River Leam viaduct	Offchurch cutting	Moderate adverse	Not located within zone of influence therefore unlikely to receive adverse impacts from changes to groundwater. However, the watercourse is maintained by the issues present on the Secondary A superficial aquifer. Groundwater levels may be reduced in this aquifer which may reduce flow to the surface watercourse via the issues.	SuDS such as infiltration trenches will be located to the south of Offchurch Cutting to facilitate groundwater recharge.	Negligible Neutral (not significant)	None required	Negligible Neutral (not significant)	Construction (Permanent)

4 References

British Geological Survey (1997), *The Physical Properties of Major Aquifers in England and Wales*.

Domenico, P.A. and F.W. Schwartz (1990), *Physical and Chemical Hydrogeology*, John Wiley & Sons, New York.

Hiscock, K.M. (2005), *Hydrogeology: Principles and Practice*, Blackwell Science Ltd, Oxford.

The Environment Agency (2009), *River Basin Management Plan – Severn River Basin District*.

Tellam J.H. and Lloyd J.W. (1981), A review of the hydrogeology of British onshore non-carbonate mudrocks. *Quarterly Journal of Engineering Geology and Hydrogeology* 1981, v.14; p347-355.